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TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: 9694-000002 PCT

U.S APPLICATION NO (If known, see 37 CFR 1 5): 09/869452

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/JP99/07324	27 December 1999 (27.12.99)	28 December 1998 (28.12.98)

TITLE OF INVENTION: LIBRARY SYSTEM

JC04 Rec'd PCT/PTO 27 JUN 2001

APPLICANT(S) FOR DO/EO/US KUWAYAMA, Noritada

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND or SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [ ] This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. [X] The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [ ] is attached hereto (required only if not communicated by the International Bureau).
   b. [X] has been communicated by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [X] An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. [X] is attached hereto.
   b. [ ] has been previously submitted under 35 U.S.C. 154(d)(4).
7. [X] Amendments to the claims of the International Aplication under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are attached hereto (required only if not communicated by the International Bureau).
   b. [ ] have been communicated by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [X] have not been made and will not be made.
8. [ ] An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. [ ] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [ ] An English lanugage translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. [X] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [ ] A FIRST preliminary amendment.
14. [ ] A SECOND or SUBSEQUENT preliminary amendment.
15. [ ] A substitute specification.
16. [ ] A change of power of attorney and/or address letter.
17. [ ] A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. [ ] A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. [ ] A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. [X] Other items or information:

Application Data Sheet, 6 sheets of Formal Drawings showing Figs. 1 - 9, PTO Form 1449 with copies of English language translation of references cited thereon (2 JP, 1 EP), English language Translations of International Search Report and International Preliminary Examination Report and return postcard.

JC03 Rec'd PCT/PTC 27 JUN 2001

U.S. APPLICATION NO (if known, see 37 CFR 1.5) 09/869452	INTERNATIONAL APPLICATION NO PCT/JP99/07324	ATTORNEY'S DOCKET NUMBER 9694-000002

21. ☒ The following fees are submitted:	CALCULATIONS PTO USE ONLY	
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a (2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1000.00**		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$860.00**		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$710.00**		
International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$690.00**		
International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 860.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$ 0.00	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	$	
Total claims	2 -20 =	0	**x $18.00**	$ 0.00	
Independent claims	2 -3 =	0	**x $80.00**	$ 0.00	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			**+ $270.00**	$ 0.00	
TOTAL OF ABOVE CALCULATIONS =				$ 860.00	
☒ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2. +				$ 430.00	
SUBTOTAL =				$ 430.00	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				$ 0.00	
TOTAL NATIONAL FEE =				$ 430.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$ 0.00	
TOTAL FEES ENCLOSED =				$ 430.00	
				Amount to be refunded:	$
				charged:	$

a. ☒ A check in the amount of $ 430.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of $ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 08-0750. A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

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28,764
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S P E C I F I C A I T O N

LIBRARY SYSTEM

FIELD OF THE INVENTION

The present invention relates to a library system for storing a plurality types of information recording media (e.g., CD-ROMs, DVD-RAMs, DVD-ROMs), and for unloading and then reproducing any one of the stored information recording media.

BACKGROUND OF THE INVENTION

There have been known library systems or jukeboxes for storing a number of information recording media including read-only or rewritable magnetic disks / optical magnetic disks and/or tape units, and unloading to reproduce a selected information recording medium. Some of them include one library unit that houses a number of recording medium storage sections, a plurality of recording medium reproduction sections, and a transfer sections for transferring a recording medium between the recording medium storage sections and the recording medium reproduction sections. In the meantime, with a development of the communication facilities, another types of systems having a plurality of library units are becoming to be

popular.

Meanwhile, the library system requires a suitable application program or programs in accordance with the type of information recording media and the intended use of the system. For this purpose, for example AMASS™ is available for using the system as a virtual file system, Tracer™ for recording in and reading from an optical magnetic disk, SmartCD™ for reading a CD-ROM and a CD-R, and Networker™ for the backup of data.

However, in a conventional library system, one application is associated with one library unit. This results in that for a library system with a plurality of library units, each application is correlated with each library unit. Hence, for instance, when a user having one unit only for reading information from CD-ROMs wishes to record CD-ROM's data in a tape unit, the user has no other option but to purchase an additional unit and use the same as a unit only for the tape unit.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide a library system in which one library unit is divided into a plurality of virtual units so that it is possible to use the divided plurality of virtual units each as an individually controllable library unit. Further,

another object of the present invention is to provide a library system in which it is possible to individually control virtual units which are across more than one library units.

To achieve the objects above, a library system according to a first embodiment of the present invention specifically comprises a host computer, a library unit, and a communication apparatus which connects the host computer and the library unit with each other for communications. The library unit above comprises one cabinet, and disposed in the cabinet are; a plurality of recording medium storage sections, a plurality of recording medium reproduction sections which receive recording media which are stored in the respective recording medium storage sections and reproduce the recording media; a recording medium transportation section for transporting the recording media each between the recording medium storage sections and the recording medium reproduction sections and a controller for controlling the recording medium reproduction sections; and the recording medium transportation section. The plurality of recording medium storage sections above are divided into a plurality of storage stations, the plurality of recording medium reproduction sections are divided into a plurality of reproduction stations which correspond to the storage stations, and each storage station and the corresponding

reproduction station constitute a virtual unit. The host computer described above includes applications which correspond to the virtual units above to control the virtual units individually, and controls the virtual units in accordance with the corresponding applications.

A library system according to a second embodiment of the present invention comprises a host computer, a first and a second library units, and a communication apparatus which connects the host computer and the first and the second library units with each other for communications. Each one of the first and the second library units comprises one cabinet which is independent of other library units, and disposed in the cabinet are: a recording medium storage section; a recording medium reproduction section which receives a recording medium which is stored in the recording medium storage section and reproduces the recording medium; a recording medium transportation section for transporting the recording medium between the recording medium storage section and the recording medium reproduction section; and a controller for controlling the recording medium reproduction section and the recording medium transportation section. At least a portion of the recording medium storage section and at least a corresponding portion of the recording medium reproduction section constitute a virtual unit portion, and the virtual

unit portion in the first library unit and the virtual unit portion in the second library unit above constitute one virtual unit. The host computer described above includes applications which correspond to the virtual units above to control the virtual units individually, and controls the virtual units in accordance with the corresponding applications.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic diagram showing an overall structure of a library system according to the present invention;

Fig. 2 is a side elevational view showing a structure of a library unit for use in the library system shown in Fig. 1;

Fig. 3 is a schematic view showing a structure of virtual units in the library system in Fig. 1;

Fig. 4 is a schematic view of a structure in which two virtual units share portions of a storage section and a reproduction section;

Fig. 5 is a schematic side elevational view showing a structure of a library system having a plurality of library units;

Fig. 6 is a schematic view for describing a logical structure of a controller included in the library

system in Fig. 5;

Fig. 7 is a schematic side elevational view showing a structure of a library system having other communication apparatus;

Fig. 8 is a schematic side elevational view showing that controllers in library units arranged in a raw are connected with each other by infrared devices; and

Fig. 9 is a schematic view of a structure in which a plurality of virtual units share one I/E section.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference to the drawings, preferred embodiments according to the present invention will be described hereinafter. Fig. 1 shows a general structure of a library system 10 according to the present invention. The library system 10 (hereinafter referred to simply as "system 10") has a server machine (host computer) 12 which functions as a controller for controlling the system 10 as a whole, and a data library (or jukebox) 14 which stores and reproduces a number of recording media. In this embodiment, the data library 14 includes a library unit 16. Used for the electric connection between the server machine 12 and the library unit 16 is an input/output interface (communication device), SCSI (Small Computer System Interface). Specifically, the server machine 12 and the

library unit 16 are communicated to each other through a SCSI bus 18, allowing the library unit 16 to operate in response to a signal from the server machine. Of course, the server machine 12 may be connected with one or more client machine (computer) 20 so that the library unit 16 operates in response to a signal from the client machine 20. The server machine 12 and the client machine 20 may be any one type of computers currently available on networks. Further, a variety of operating systems currently available on networks, including Windows NT™, Linux™ and Solaris™, may be used for controlling the server machine 12 and the client machines 20 systematically on the network.

Next, Fig. 2 shows a schematic structure of the library unit 16. The library unit 16 has a housing or cabinet 22 for receiving various components (described in detail hereinafter) contained in the library unit 16. Mounted within the cabinet 22 is a recording medium transfer section 23. The recording medium transfer section 23 has a guide 24 arranged in the vertical direction. The guide 24 supports a handler (recording medium transfer section) 26 for the transfer of a recording medium so that the handler 26 moves ups and downs along the guide 24 and rotates around the guide 24 or another vertical axis. Structures of the recording medium transfer section 23, the guide 24 and the handler 26 are described in detail in the

U.S. patent application No. 09/380,217 filed by the applicant of this application, which is incorporated herein by reference. It should be noted that the structure of the recording medium transfer section 23 is not limited to this embodiment.

A recording medium storage section 30 and a recording medium reproduction section 32 are provided around a space in which the handler 26 moves ups and downs and rotates about the vertical axis. In the preferred embodiment, the storage and reproduction sections, 30 and 32, are arranged so that they surround the space 30. However, the storage and reproduction sections may be arranged in the form of matrix on a vertical wall, so that the recording medium transportation section moves in the vertical and horizontal directions. This type of library system is described in the U.S. patent application No. 08/980,059, which is incorporated herein by reference.

In this embodiment, the recording medium storage section 30 has six hundreds of pallets 34 arranged in tiers so that six hundreds of recording medium in the form of disc with normal size (diameter of about 12cm) can be housed in the section. Also in this embodiment, the storage section 30 is divided into three storage stations 30_0, 30_1, and 30_2 for receiving three types of disc-like recording media, e.g., CD-ROMs, DVD-RAMs and DVD-ROMs.

More specifically, in this preferred embodiment, the first to the 300th pallets 34 are allotted to the storage station 30_0 for the storage of CD-ROMs, the 301st to the 450th pallets 34 to the storage station 30_1 for the storage of DVD-RAMs, and the 451st to the 600th pallets 34 to the storage station 30_2 for the storage of DVD-ROMs. It should be noted that the number of the storage stations and the types of recording media to be stored in the respective storage stations are not limited to this embodiment.

The recording medium reproduction section 32 is divided into three reproduction stations 32_0, 32_1 and 32_2 corresponding to the three types of recording media (CD-ROMs, DVD-RAMs and DVD-ROMs) stored in the storage section 30. Each reproduction station has one or more drives (recording medium reproduction device) capable of reproducing corresponding recording media. Although the reproduction section is divided into three to store the three types of recording media in this preferred embodiment, it is preferable to divide the reproduction section into four where there are four or more types of recording media. Where one reproduction device can reproduce two or more types of recording media, the number of the reproduction stations may be smaller than that of the storage stations.

The three reproduction stations 32_0, 32_1 and 32_2 correspond to the three storage stations 30_0, 30_1 and 30_2,

respectively. The storage station 30_0 and the reproduction station 32_0 constitute a virtual unit 36_0, the storage station 30_1 and the reproduction station 32_1 constitute a virtual unit 36_1, and the storage station 30_2 and the reproduction station 32_2 constitute a virtual unit 36_2.

An I/E (Import/Export) station 38 for loarding and unloading the recording media into and from the cabinet 22 is positioned in an upper portion of the library unit 16 to face an upper portion of the central space 28. Although not shown, the I/E station 38 has a recording medium load/unload opening which is formed in a front wall of the cabinet 22 facing an operator. Hence, the recording medium supplied to the I/E station 38 through the opening is held by the handler 26, allowing the recording medium to be placed in a predetermined one of the pallets 34 which is designated by the server machine 12. Further, the handler 26 unloads the recording medium held in the predetermined pallet 34 which is designated by the server machine 12, allowing the recording medium to be taken out through the I/E station 38 and the opening of the I/E station 38. Similar to the handler 26, only one I/E station 38 provided in one library unit 16 so that it is used as equipment to be shared among the three virtual units 36_0 (VL0), 36_1(VL1) and 36_2 (VL2).

The library unit 16 further has a controller 40

for controlling driving of the handler 26, the storage stations and the reproduction stations in response to an instruction from the server machine 12. The controller 40 is connected with the server machine 12 for communication via the SCSI bus 18. More specifically, for an input/output interface, used in this embodiment is a SCSI capable of driving eight devices (whose identification numbers being ID0 through ID7). Therefore, the identification number ID0 is assigned to the server machine 12 and the identification number ID1 is assigned to the controller 40. Further, as shown in Fig. 3, logically the controller 40 is divided into three controls 40_0, 40_1 and 40_2 (whose logic unit numbers being LUN0, LUN1 and LUN2). The controls 40_0, 40_1 and 40_2 (whose logic unit numbers being LUN0, LUN1 and LUN2) correspond to the three virtual units 36_0, 36_1 and 36_2 described above.

Referring again to Fig. 3, the server machine 12 includes a storage memory (e.g., hard disk 42). The hard disk 42 stores three dedicated applications 44_0, 44_1 and 44_2 (e.g., Tracer™, AMASS™) which correspond to the three recording media (CD-ROMs, DVD-RAMs and DVD-ROMs). The applications 44_0, 44_1 and 44_2 correspond respectively to the logic unit numbers LUN0, LUN1 and LUN2 (namely, the virtual units 36_0, 36_1 and 36_2). The server machine 12 and the controller 40 are set up such that the virtual units 36_0,

36_1 and 36_2 operate respectively in accordance with the corresponding applications 44_0, 44_1 and 44_2. Instead, one application may control more than one logic units.

With the system 10 so constructed, as shown in Fig. 3, the three virtual units 36_0, 36_1 and 36_2 are displayed on screens of the server machine 12 and the client machine 20. That shows that, although only one library unit 16 is connected with the system 10 in reality, when viewed from the server machine 12 and the client machine 20, it appears as if three library units are connected with the system 10.

This allows the server machine 12 or the client machine 20 to energize any desired one of the virtual units 36_0, 36_1 and 36_2 which are displayed on the screen and to reproduce a desired recording medium. More specifically, in the server machine 12 or the client machine 20, as reproduction is instructed together with a designation of a specific pallet stored in the storage station 30_0 of the virtual unit 36_0, the associated application 44_0 stored in the hard disk 42 of the server machine 12 energizes. This in turn causes the controller 40 to control an operation of the associated virtual unit 36_0. As a result, the handler 26 ascends or descends along the guide 24, moving close to the designated pallet 34. Next, the handler 26 unloads the designated pallet 34 together with the CD-ROM held in the

pallet 34 from the storage station 30_0 and holds the CD-ROM. Subsequently, the handler 26 moves to a position opposed to a designated CD-ROM drive of the associated reproduction station 32_0, rotates if necessary, and passes the CD-ROM together with the pallet 34 to the drive.

After the completion of the reproduction of the CD-ROM, the handler 26 receives the CD-ROM and the pallet from the drive, and returns them to the original position within the storage station 30_0. Likewise, the DVD-RAMs and the DVD-ROMs held in the virtual units 36_1, 36_2 are transported between the storage stations 30_1, 30_2 and the reproduction stations 32_1, 32_2.

For unloading of the recording media from the library unit 16 as well, in a similar manner, a desired virtual unit and a wanted pallet shown on the screen are designated using the server machine 12 or the client machine 20. This energizes the corresponding application installed in the server machine 12, whereby the controller 40 operates so that the handler 26 ascends or descends, unloads the designated pallet together with the CD-ROM from the storage station, and passes them to the I/E station 38.

The foregoing is directed to one preferred embodiment of the present invention, and therefore, the present invention is not limited to this.

For example, the recording media are not limited

to those described above. Any recording media capable of being managed by the library units are applicable to the present invention, in particular including tape units such as DLT, 3590, 8mm and AIT, DVD-RAM, DVD-ROM, DVD-R, DVD+RW, DVD-RW, CD-ROM, CD-R, CD-RW, CD-Audio, CD-I, CD-DA, CD-ROM XA and optical magnetic disks (MO).

In addition, although in the previous embodiment SCSI is used for the input/output interface between the server machine 12 and the controller 40, it may be replaced by RS232C, a network interface (e.g., fiber channel, Ethernet), a built-in interface mounted in a server machine, and the like.

Further, although only two pieces of equipment (one server machine 12 and one controller 40) are connected to the SCSI bus which can accept up to eight machines in the previous embodiment, the present invention is not limited to this. Of course, other machines may be additionally connected.

While the respective virtual units 36_0, 36_1 and 36_2 are independent of other virtual units in the previous embodiment, a plurality of virtual units may share a portion of a recording medium storage/reproduction station. For example, a DVD-RAM drive can reproduce CD-Rs. Hence, as shown in Fig. 4, a recording medium storage/reproduction station 46_0 for DVD-RAMs may be partially used as a portion

of a recording medium storage/reproduction station 46_1 for CD-Rs. In this instance, when it becomes impossible to store recording media each in a storage area only for DVD-RAMs or a storage area only for CD-Rs, the recording media can be stored temporarily in a shared area (DVD-RAM/CD-R station 46_2). This allows the library unit 16 to be used so effectively.

Besides, although the data library is formed by one library unit in the preferred embodiment above, the present invention is applicable to a data library which is formed by connecting a plurality of library units with each other.

For example, in Fig. 5, a data library 50 is formed by a plurality of library units 52_0, 52_1, 52_2 ... which are arranged in a row. The library units 52_0, 52_1, 52_2 ... are serially linked by a medium transportation section 54 so that a recording medium can be transported among the library units. The medium transportation section 54 has delivery mechanisms 56_0, 56_1, 56_2 ... for delivery of a recording medium between the adjacent library units, and transportation mechanisms 58_0, 58_1, 58_2 ... for transporting a recording medium supplied from the adjacent library unit through the delivery mechanism to the recording medium reproduction section or I/E stations 38_0, 38_1, 38_2 ..., or the like. The handler described in the first embodiment

may be used for the transportation mechanisms.

Hence, by the use of the medium transportation section 54, a recording medium stored in the library unit 52_0 is transported to the first library unit 52_1 where it is thereafter reproduced in the reproduction section of the library unit 52_1 or unloaded from the I/E station 38_1 of the library unit 52_1. The medium transportation section 54 is described in detail in the U.S. patent application No. 09/380,217 filed by the applicant of the present application and also the corresponding Japanese Patent Application Laid-Open Publication No. H9-22561, and the disclosure of the U.S. patent application is incorporated herein by reference.

The storage section and the reproduction section of each one of the library units 52_0, 52_1, 52_2 ... are divided logically into a plurality of virtual units. In this embodiment, the storage section and the reproduction section of the library unit 52_0 are divided into a virtual unit 60_0 and a virtual unit 60_1. The storage section and the reproduction section of the library unit 52_1 are incorporated into a portion of the virtual unit 60_1, and the remaining portion exists as a virtual unit 60_2. The storage section and the reproduction section of the library unit 52_2 exist entirely as a portion of the virtual unit 60_2. As in the first embodiment which uses only one

library unit, each virtual unit includes a plurality of pallets for storing a plurality of recording media and one or more reproduction apparatuses for reproducing these recording media. Where one virtual unit is composed of portions of several library units, each virtual unit portion (e.g., a portion of the virtual unit 60_1 contained in the library unit 52_0) naturally includes a plurality of pallets for storing a plurality of recording media and one or more reproduction apparatuses for reproducing the recording media.

Even where a library unit housing the transportation mechanisms (handlers) 58_0, 58_1, 58_2 ... is divided into a plurality of virtual units, the transportation mechanisms 58_0, 58_1, 58_2 ... are shared by the divided virtual units. On the other hand, the I/E stations 38_0, 38_1, 38_2 ... are assigned each to each one of the virtual units. For example, the I/E stations 38_0, 38_1, 38_2 ... of the library units 52_0, 52_1, 52_2 ... are assigned to the virtual units 60_0, 60_1, 60_2 ..., respectively. The delivery mechanism 56_0 which links the library units 52_0, 52_1 is assigned to the virtual unit 52_1, which allows to transport a recording medium in the virtual unit 60_1 within the library unit 52_0 to the I/E station 38_1 of the library unit 52_1 through the delivery mechanism 56_0. Further, when one virtual unit is assigned to the library unit 52_0 and

other virtual unit is assigned to the adjacent library unit 52_1, the delivery mechanism functions as an I/E station between the two virtual units. Likewise, the delivery mechanism 56_1 which links the library units 52_1, 52_2 is assigned to the virtual unit 60_2, which allows to transport a recording medium in the virtual unit 60_2 within the library unit 52_1 to the I/E station 38_2 of the library unit 52_2 through the delivery mechanism 56_1.

Controllers 62_0, 62_1, 62_2 ... of the library units 52_0, 52_1, 52_2 ... are set up so as to control operations of the respective associated library units. Further, as shown in Fig. 6, logically the respective controllers 62_0, 62_1, 62_2 ... are divided appropriately in accordance with the virtual units 60_0, 60_1, 60_2 ... which are divided as described above. More specifically, the controller 62_0 is divided into a control section 62_{00} which corresponds to the virtual unit 60_0 and a control section 62_{01} which corresponds to a portion of the virtual unit 60_1 which exists in the library unit 52_0. Likewise, the controller 62_1 is divided into a control section 62_{10} which corresponds to the remaining portion of the virtual unit 60_1 in the library unit 52_1 and a control section 62_{11} which corresponds to a portion of the different virtual unit 60_2 in the library unit 52_1. However, since the virtual unit 60_2 alone is assigned to the library unit 52_2, the

controller 62_2 is in its entirety assigned to a control section 62_{20} of the virtual unit 60_2.

As described above, the respective controllers 62_0, 62_1, 62_2 ... are divided logically, and each one of the controllers 62_0, 62_1, 62_2 ... must control, without any interference, the portion of the corresponding virtual unit (e.g., the virtual unit 60_1) which physically exists across more than one library units. To this end, the controllers 62_0, 62_1, 62_2 ... are connected with each other by a communication device 64, and further, the controller 62_3 is connected with a server machine not shown via the communication device. Hence, the controllers 62_0, 62_1, 62_2 ..., when viewed as a whole, constitute one integrated controller which is divided logically and control each one of the virtual units 60_0, 60_1, 60_2 ... in response to an instruction from the server machine. As in the first embodiment described above, the SCSI bus 18 is used for the communication device. The identification number ID0 of the SCSI bus 18 is assigned to the server machine and the identification number ID1 is assigned to the controller 62_0. Also, the virtual units 60_0, 60_1, 60_2 ... are tied with the logic unit numbers are LUN0, LUN1, LUN3 ... by the identification number ID1.

The electric connection between the server machine and the controller shown in Fig. 5, of course, is

one example. For example, as shown in Fig. 7, the controller 62_0 may be connected with the server machine via a SCSI bus 1, and the other controllers 62_1, 62_2 ... may be connected with the server machine via a different SCSI bus 2. In addition, either one of the server machine and the controllers may be connected using a network interface (e.g., fiber channel, Ethernet).

With the library so constructed, the screen of the server machine or the client machine does not show that a plurality of library units exist but shows only the virtual units 60_0, 60_1, 60_2 ..., which a user refers to for selecting, reproducing and unloading a desired recording medium. For example, when a recording medium is to be reproduced, a user designates a virtual unit displayed on the screen and selects a desired recording medium which is stored in the virtual unit. As shown in Fig. 5, for example, for the purpose of reproducing a recording medium which is stored in the portion of the virtual unit 60_1 portion in the library unit 52_0, the control section 62_{01} which corresponds to this virtual unit portion unloads and reproduces the wanted recording medium. Likewise, when a recording medium stored in the virtual unit 60_1 portion of the library unit 52_1 is to be reproduced, the control section 62_{10} which corresponds to this virtual unit portion unloads and reproduces the wanted recording medium.

For unloading a recording medium, where a desired recording medium is stored in the virtual unit 60_0, for example, this recording medium is unloaded through the I/E station 38_0 of the library unit 52_0. However, where a desired recording medium is stored in a portion of the virtual unit 60_1 of the library unit 52_0, this recording medium is transported by the transportation mechanism 58_0 inside the library unit 52_0. Next, the recording medium is passed to the delivery mechanism 56_0 from the transportation mechanism 58_0, thereafter supplied by the transportation mechanism 58_1 which is disposed within the library unit 52_1 to the I/E station 38_1, and unloaded to outside through the I/E station 38_1.

Although one virtual unit utilizes the storage section and the reproduction section only between adjacent library units, the present invention is not limited to this. For example, portions each of two or more non-adjacent library units may constitute one virtual unit.

Further, a communication cable may be used as the communication device 64 for the connection of controllers. Alternatively, as shown in Fig. 8, where the library units 52_0, 52_1, 52_2 ... are arranged in a row, another communication device 66 utilizing infrared light may be used to connect the controllers 62_1, 62_2 ... in series. However, when a plurality of library units are located in

different places, another communication means utilizing light or radio (e.g., Altair-J, AT&T WaveLAN) may be used.

While the I/E stations 38_0, 38_1, 38_2 ... are each assigned to each one of the virtual units 60_0, 60_1, 60_2 ... in the previous embodiment, it is of course possible to allow more than virtual units to share one I/E station as shown in Fig. 9. In this instance, a controller may control virtual units other than those of a library unit which houses this controller.

As can be seen from the foregoing, with the library system according to the present invention, it is possible to handle a plurality of recording media using one library unit. Hence, even when a plurality of recording media are to be handled, one library unit is sufficient if the recording media to be handled are not in a great number. Further, where a plurality of library units are used, it is possible to make a sufficient use of a medium storage capacity of each library unit. Moreover, even where a user uses a plurality of applications, it is not necessary to purchase the same number of library units as the number of the applications, which is economical.

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CLAIMS:

1. A library system comprising a host computer, a library unit and a communication apparatus which connects said host computer and said library unit with each other for communications, characterized in that:

(a) said library unit comprises one cabinet, and disposed in said cabinet are: a plurality of recording medium storage sections; a plurality of recording medium reproduction sections which receive recording media which are stored in said recording medium storage sections and reproduce the recording media; a recording medium transportation section for transporting the recording media each between said recording medium storage sections and said recording medium reproduction sections; and a controller for controlling said recording medium reproduction sections and said recording medium transportation section,

said plurality of recording medium storage sections are divided into a plurality of storage stations,

said plurality of recording medium reproduction sections are divided into a plurality of reproduction stations,

each storage station and the corresponding reproduction station constitute a virtual unit, and

(b) said host computer includes applications which correspond to said virtual units to control said virtual units individually.

2. A library system comprising a host computer, a first and a second library units, and a communication apparatus which connects said host computer and said first and said second library units with each other for communications, characterized in that:

(a) each one of said first and said second library units comprises one cabinet which is independent of other library units, and disposed in said cabinet are: a recording medium storage section; a recording medium reproduction section which receives a recording medium which is stored in said recording medium storage section and reproduces the recording medium; a recording medium transportation section for transporting the recording medium between said recording medium storage section and said recording medium reproduction section; and a controller for controlling said recording medium reproduction section and said recording medium transportation section,

at least a portion of said recording medium storage section and at least a corresponding portion of said recording medium reproduction section constitute a virtual

unit portion,

a virtual unit portion in said first library unit and a virtual unit portion in said second library unit constitute one virtual unit, and

(b) said host computer includes applications which correspond to said virtual units to control said virtual units individually.

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Fig.1

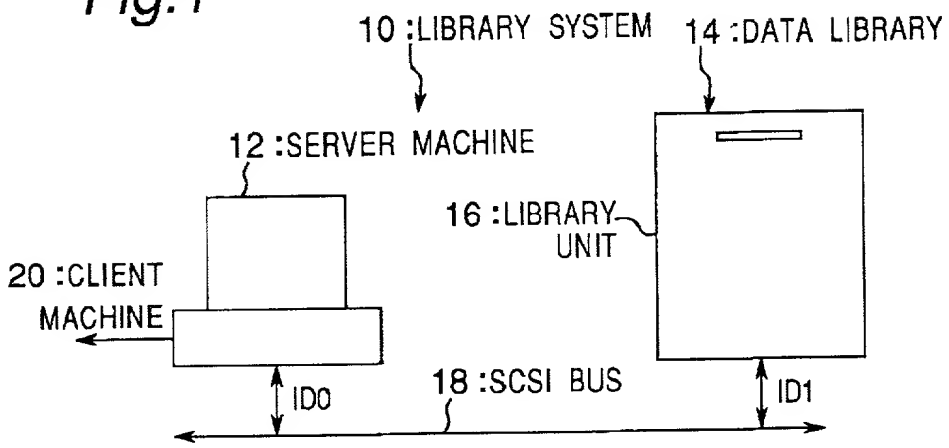

10 :LIBRARY SYSTEM
14 :DATA LIBRARY
12 :SERVER MACHINE
16 :LIBRARY UNIT
20 :CLIENT MACHINE
ID0
18 :SCSI BUS
ID1

Fig.2

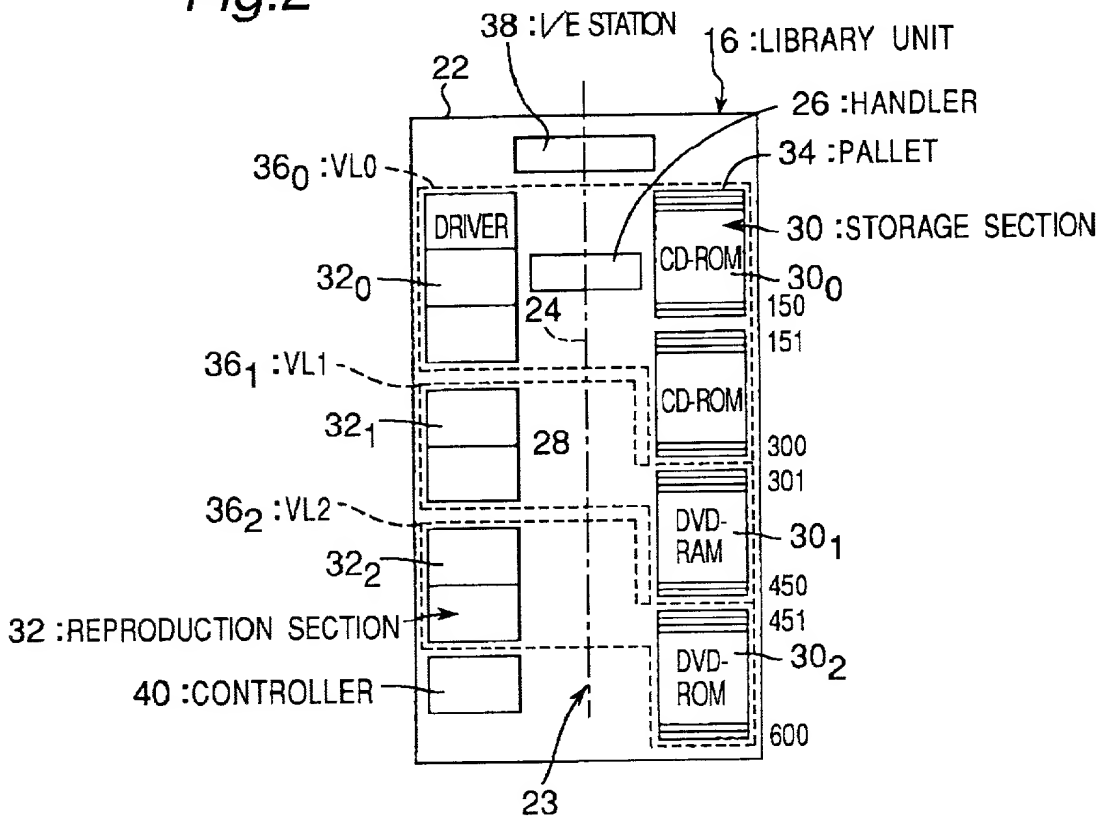

38 :I/E STATION
16 :LIBRARY UNIT
22
26 :HANDLER
34 :PALLET
36_0 :VL0
DRIVER
30 :STORAGE SECTION
32_0
CD-ROM
30_0
24
150
151
36_1 :VL1
CD-ROM
32_1
28
300
301
36_2 :VL2
DVD-RAM
30_1
32_2
450
451
32 :REPRODUCTION SECTION
DVD-ROM
30_2
40 :CONTROLLER
600
23

Fig.3

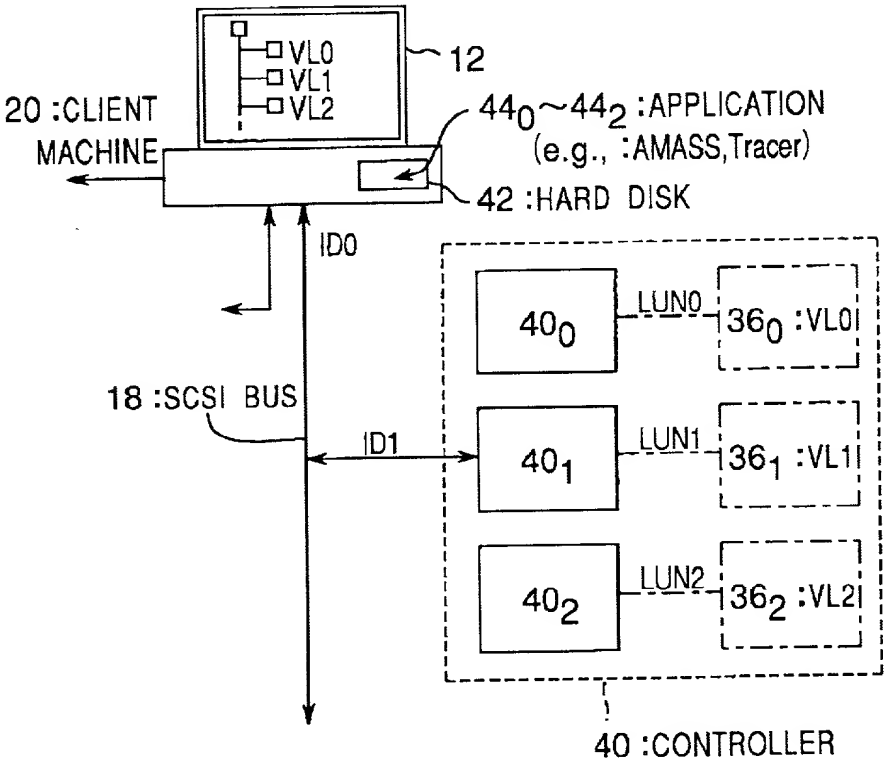

VL0
VL1
VL2
12
20 :CLIENT MACHINE
44_0~44_2 :APPLICATION
(e.g., :AMASS,Tracer)
42 :HARD DISK
ID0
40_0
LUN0
36_0 :VL0
18 :SCSI BUS
ID1
40_1
LUN1
36_1 :VL1
40_2
LUN2
36_2 :VL2
40 :CONTROLLER

Fig.4

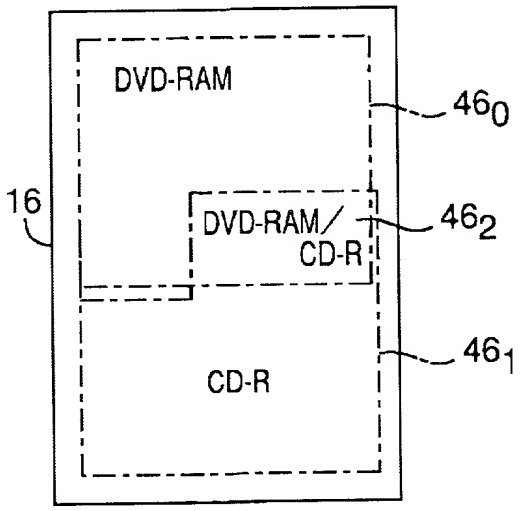

DVD-RAM
46_0
16
DVD-RAM/
CD-R
46_2
46_1
CD-R

Fig.5

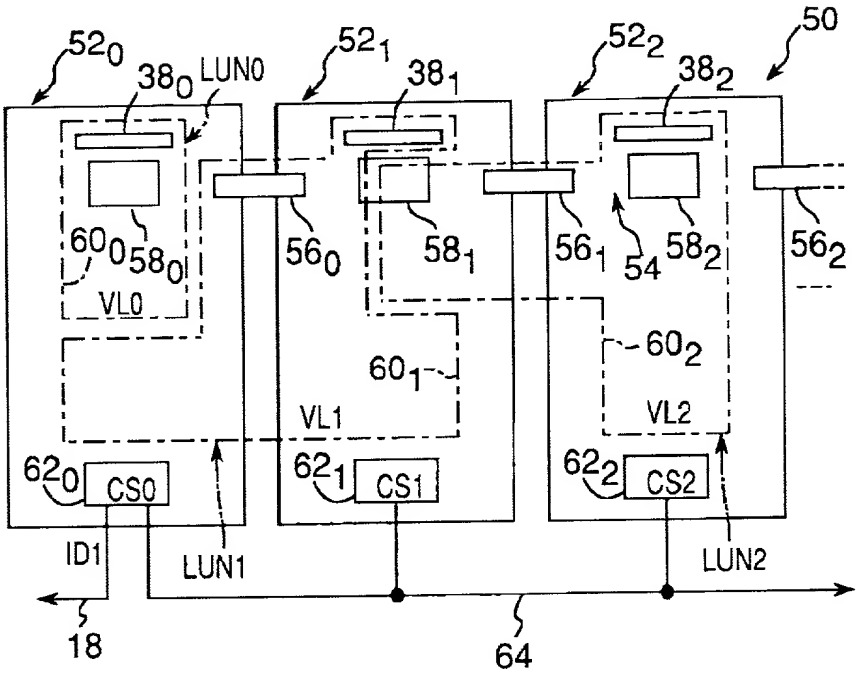

52_0
38_0
LUN0
52_1
38_1
52_2
38_2
50
60_0
58_0
56_0
58_1
56_1
54
58_2
56_2
VL0
60_1
60_2
VL1
VL2
62_0
CS0
62_1
CS1
62_2
CS2
ID1
LUN1
LUN2
18
64

Fig.6

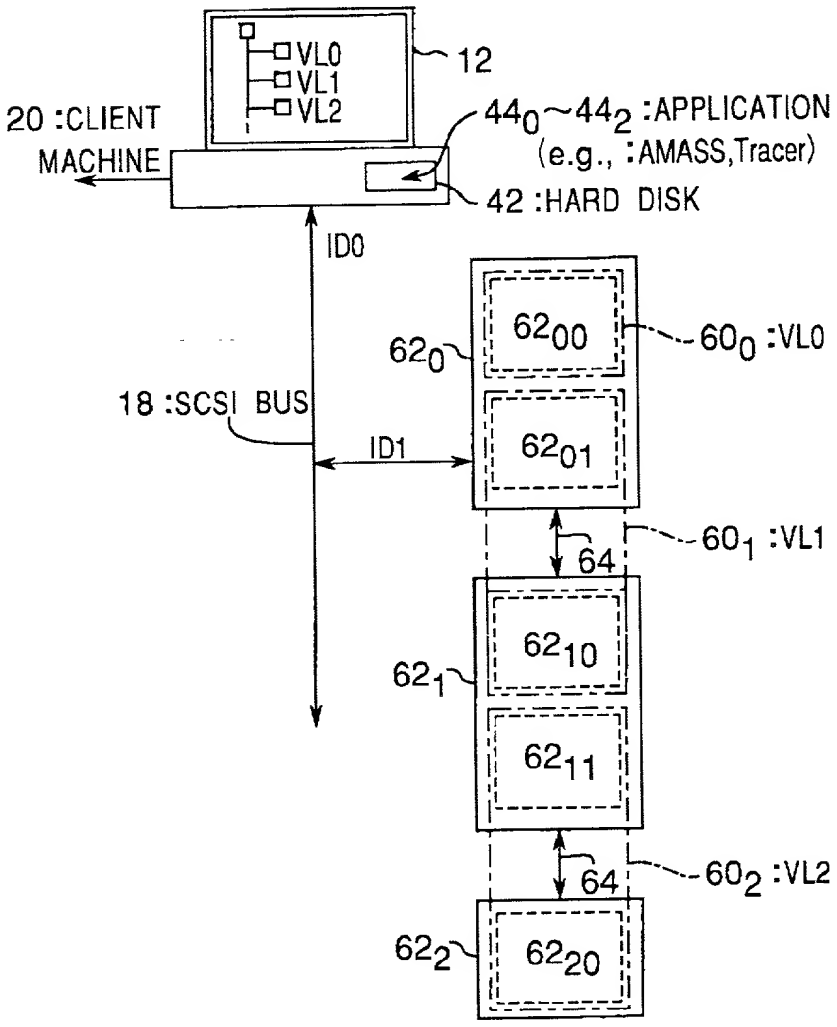

VL0
VL1
VL2
12
20 :CLIENT MACHINE
44_0~44_2 :APPLICATION (e.g., :AMASS,Tracer)
42 :HARD DISK
ID0
62_{00}
60_0 :VL0
62_0
18 :SCSI BUS
ID1
62_{01}
60_1 :VL1
64
62_{10}
62_1
62_{11}
64
60_2 :VL2
62_2
62_{20}

Fig.7

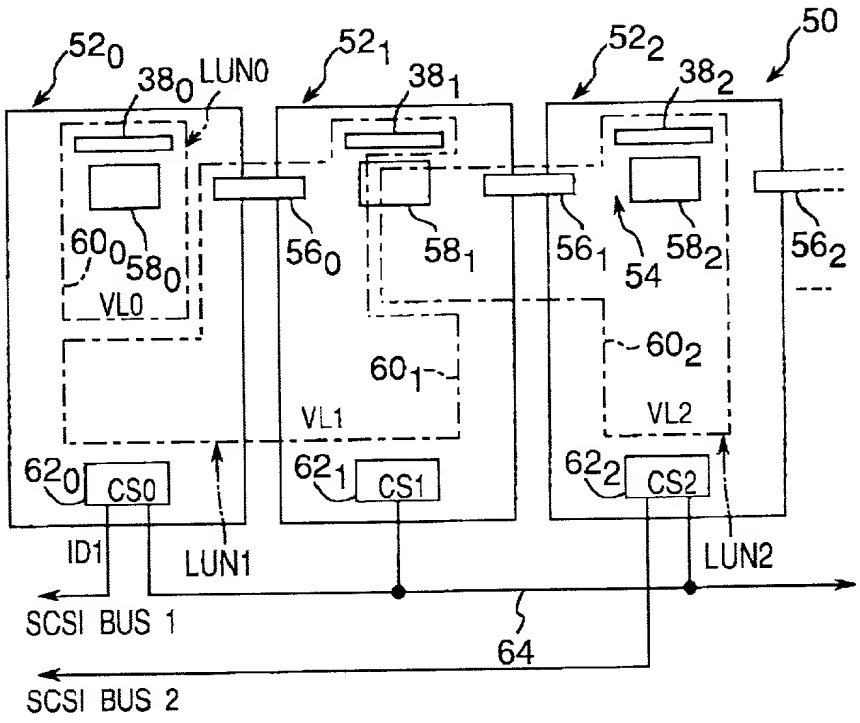

52_0
38_0
LUN0
52_1
38_1
52_2
38_2
50
60_0
58_0
VL0
56_0
58_1
56_1
54
58_2
56_2
60_1
VL1
60_2
VL2
62_0
CS0
62_1
CS1
62_2
CS2
ID1
LUN1
LUN2
SCSI BUS 1
64
SCSI BUS 2

Fig.8

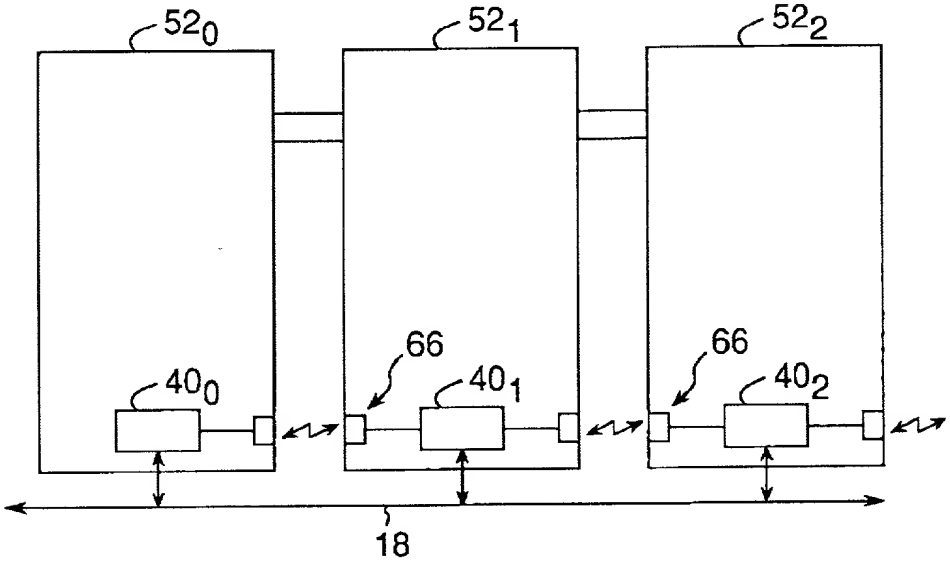
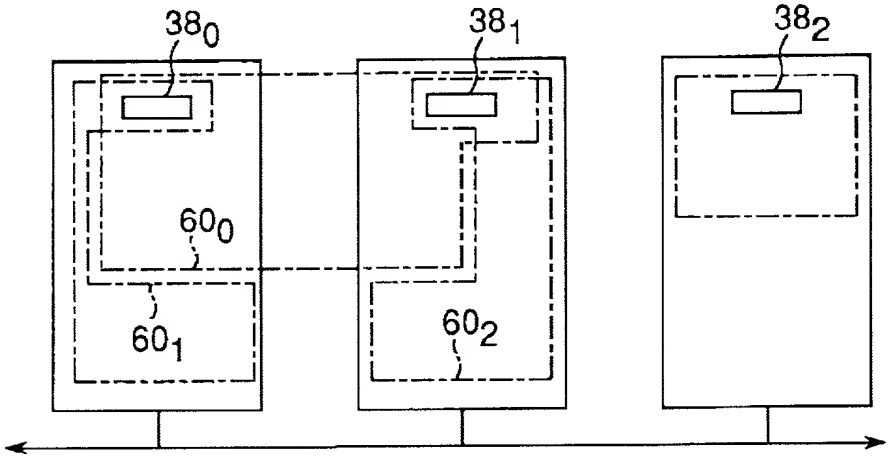


Fig.9



DECLARATION AND POWER OF ATTORNEY

Atty. Dkt. No.: 9694-000002

DECLARATION

As a below named inventor, I hereby declare that:

My residence, mailing address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

LIBRARY SYSTEM

the specification of which (check one)

☐ is attached hereto.
or
☒ was filed on December 27, 1999 as Application Serial No. or PCT International Application No. PCT/JP99/07324 and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I hereby claim foreign priority benefits under 35 U.S.C. §§ 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or any PCT international application having a filing date before that of the application on which priority is claimed:

PRIOR FOREIGN APPLICATION(S)				
APPN. SERIAL NO.	COUNTRY	DATE FILED (MM/DD/YYYY)	PRIORITY CLAIM	
			Yes	No
10-372862	Japan	28/December/1998	☒	☐
			☐	☐
			☐	☐

DECLARATION AND POWER OF ATTORNEY

I hereby claim the benefit under 35 U.S.C. § 119(e) of any United States provisional application(s) listed below:

PRIOR PROVISIONAL APPLICATION(S)	
APPN. SERIAL NO.	DATE FILED (MM/DD/YYYY)

I hereby claim the benefit under 35 U.S.C. § 120 of any United States application(s) listed below:

PRIOR U.S. APPLICATION(S)		
APPN. SERIAL NO.	DATE FILED (MM/DD/YYYY)	STATUS - PATENTED, PENDING, ABANDONED

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

POWER OF ATTORNEY

I hereby appoint each practitioner at Customer No. 27572 ( ) of Harness, Dickey & Pierce, P.L.C., my attorney with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.

CORRESPONDENCE ADDRESS

I request the Patent and Trademark Office to direct all correspondence and telephone calls relative to this application to Customer No. 27572 ( ), Harness, Dickey & Pierce, P.L.C., P. O. Box 828, Bloomfield Hills, Michigan 48303 (248) 641-1600.

DECLARATION AND POWER OF ATTORNEY

100

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Date: _____

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Date: _____

Residence:

Citizenship:

Mailing Address:

Full name of fourth joint inventor, if any:

Inventor's signature: _____

Date: _____

Residence:

Citizenship:

Mailing Address:

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